

TAXONOMIC NOTES ON KRIGIA (ASTERACEAE)

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ABSTRACT

The new combination *Krigia cespitosa* (Raf.) K.L. Chambers var. *gracilis*, based on *Apogon gracilis* DC., is proposed, and a lectotypification of the basionym is given. A neotype is created for *Serinia cespitosa* Raf. The hexaploid hybrid *Krigia* × *shinnersiana* is described from the Blue Ridge Parkway, North Carolina, representing an allopolyploid of the cross *Krigia biflora* (Walter) S.F. Blake × *Krigia montana* (Michx.) Nutt.

RESUMEN

Se propone la nueva combinación *Krigia cespitosa* (Raf.) K.L. Chambers var. *gracilis*, basada en *Apogon gracilis* DC., y se hace una lectotipificación del basiónimo. Se crea un neotipo para *Serinia cespitosa* Raf. El híbrido hexaploide *Krigia* × *shinnersiana* se describe del Blue Ridge Parkway, North Carolina, y representa un alopoliploide del cruce *Krigia biflora* (Walter) S.F. Blake × *Krigia montana* (Michx.) Nutt.

THE VARIETIES OF KRIGIA CESPITOSA

Krigia Schreb., *Nomen Conservandum*¹, has a large synonymy, considering its rather modest number of species. Shinners (1947) recognized only seven species but listed eight synonymous generic names. This excess of names may have resulted from the various authors' overemphasis on pappi differences and the contrast between annual and perennial habit within the genus. One species, as recognized here, consistently lacks pappi and, on this basis, was segregated as *Serinia* Raf. (Rafinesque 1817) and *Apogon* Elliott (Elliott 1823). DeCandolle (1838:261) placed *Serinia* in his *Compositae Incertae Sedis* but recognized *Apogon humilis* Elliott and added a second species, *Apogon gracilis* DC. These two species were again recognized by Gray (1884), and a third species, *A. wrightii* A. Gray, was described, differing from the others by the possession of "an obscure vestige of pappus." The final union of *Apogon* and *Serinia* with *Krigia* was done by Shinners (1947), who included *Krigia gracilis* (DC.) Shinners and *Krigia oppositifolia* Raf. (= *Krigia cespitosa* (Raf.) K.L. Chambers, formerly *Apogon humilis*) but placed *Apogon wrightii* Gray in synonymy under the latter species.

¹As explained by Kim and Turner (1992), the International Code of Botanical Nomenclature (Greuter et al. 1988) erroneously stated that the basionym of the conserved type species, *Krigia virginica* (L.) Willd., is *Tragopogon virginicus* L., whereas it should be *Hyoseris virginica* L. This mistake is perpetuated in the current Saint Louis Code (Greuter et al. 2000). I second the proposal by Kim and Turner that this be corrected in the next edition of the Code.

We now know much more about this cluster of taxa, from chromosome studies and the detailed molecular analyses by Kim and co-workers (Kim & Mabry 1991; Kim et al. 1992; Kim & Jansen 1994). *Krigia gracilis* and *K. cespitosa* both are diploid annuals with $n = 4$ and have similar epappose, fusiform cypselae. They are practically indistinguishable in the chloroplast cDNA and nuclear rDNA traits studied (summarized in Kim & Turner 1992). *Krigia wrightii* (A. Gray) K.L. Chambers ex K.-J. Kim is annual and tetraploid, with $n = 9$, and has more barrel-shaped cypselae often with a pappus of vestigial scales (figured in Kim & Turner 1992:180). In a cladistic analysis of cDNA and rDNA data, a 100% bootstrap value provided by 51 synapomorphies separated it from the cluster that includes *K. cespitosa* and the related *K. occidentalis* Nutt. It is probably an ancient allopolyploid between a *K. cespitosa*-like species and one of the pappus-bearing annual species of the genus (Kim & Turner 1992).

Prior to the work of Kim and Turner, systematists in Texas recognized *Krigia gracilis* and *K. cespitosa* as different species (Shinners 1958; Correll & Johnston 1970). Their emphasis was on morphological traits, especially the difference in size of heads and florets (corollas 5–10 mm long, involucre 5.3–8.5 mm high in flower, 6.2–8.5 mm high in fruit in *K. gracilis*, versus corollas 2–4 mm long, involucre 3–4.3 mm high in flower, 3.3–5.3 mm high in fruit in *K. cespitosa*). To these authors, *K. gracilis* was endemic to central and south-central Texas in the Blackland Prairie, occasionally west to the Llano region, mostly in clay-loam soil but also in adjacent regions of sandy soil, even becoming weedy in fields and disturbed ground (Shinners 1947). *Krigia cespitosa* is much more widespread, extending from central Texas east to Florida, the Carolinas, and Virginia, and north to Kansas, Missouri, and Tennessee. In herbarium studies done much earlier by the present author, the area of overlap between the varieties in Texas formed a north-south band, from Denton and Tarrant Cos. east to Hunt Co. in the north, and from Travis and Hays Cos. east to Harris Co. in the south, with an extension east to Polk and Angelina Cos. Kim and Turner (1992) took a different view of these taxa. Based on their field and herbarium studies, they extended the range of *K. gracilis* from eastern Texas to “adjacent Oklahoma, Arkansas, and Louisiana,” and they noted the presence of populations intermediate in head and flower size. Due to this pattern of intergradation and to the high similarity revealed by their DNA analysis, they proposed that the large-flowered types be reduced to the rank of *K. cespitosa* forma *gracilis* (DC.) K.-J. Kim (Kim & Turner 1992:196; Diggs et al. 1999).

My purpose here is to make a different proposal for these taxa, based on several considerations. The first is the geographical pattern, in which a widespread small-flowered type intergrades at the western edge of its range with a morphologically distinctive and geographically limited large-flowered type. Geographical races marked by interbreeding in the area of overlap are more

often accorded the rank of variety than of forma. Weight must also be given to the nature of the morphological differences, as they represent a developmentally coordinated syndrome of variation in the reproductive organs. The large-flowered race may differ in breeding system, through pollinator attraction, an increased frequency of outcrossing, and genetic mixing in the otherwise self-pollinating reproductive mode exhibited by the two varieties (Kim & Turner 1992). Intraspecific differences in reproduction associated with conspicuous floral-size differences have been noted in other genera of Cichorieae and have been accorded varietal status. Examples known to the author are *Agoseris heterophylla* (Nutt.) Raf. var. *californica* (Nutt.) Jeps. (Chambers 1963), and *Glyptopleura marginata* D.C. Eaton var. *setulosa* (A. Gray) Jeps. (Jepson 1925), both of which are large-flowered races in typically smaller-flowered species.

To allow the recognition of this morphologically distinctive geographic race at a higher taxonomic level than forma, the following combination is proposed:

Krigia cespitosa (Raf.) K.L. Chambers var. **gracilis** (DC.) K.L. Chambers, stat. nov. (Fig. 1). *Apogon gracilis* DC., Prod. 7:79. 1838. *Krigia gracilis* (DC.) Shinnery, *Wrightia* 1:205. 1947. *Krigia cespitosa* (Raf.) K.L. Chambers forma *gracilis* (DC.) K.-J. Kim, *Brittonia* 44:196. 1992. TYPE: [TEXAS] "de Bejar a Austin, Avril 1828, Berlandier No.1637" (LECTOTYPE: G-DC, the larger left-hand plant of 3 on the sheet; ISOLECTOTYPES: G, GH, US).

The need for lectotypification of the basionym was first suggested by the wording of DeCandolle's description, which includes the phrase "*achaeniis scabris brevissime papposis*." Since *Krigia gracilis*, as the name has been used by American botanists, totally lacks pappus, I became concerned that DeCandolle was dealing with a mixed collection, perhaps including *K. wrightii* or *K. occidentalis*. With the kind assistance of Dr. F. Jacquemoud and Dr. L. Gautier of the Herbarium, Conservatoire et Jardin botaniques de la Ville de Geneve, it has been determined that the Berlandier type sheet is a mixed collection, the left-hand plant possessing epappose cypselae and the right-hand plant having vestigial pappus resembling the illustration of *K. wrightii* published by Kim and Turner (1992:180). To maintain the present usage of the epithet *gracilis*, I have designated the left-hand plant as the lectotype. The isolectotype at GH studied by Shinnery and Kim consists only of *gracilis*-type plants that lack pappi. Another duplicate in the general herbarium at Geneva, ex Herbarium Moricand, clearly shows two *gracilis*-type plants and two of the pappus-bearing species. My notes from 1965 on the isolectotype at US, "ex Herb. Musei Britannici," state that it has 2 plants of the *gracilis*-type and 4 plants with muticous pappi. Whether the second species in Berlandier's collection is *K. wrightii* or a muticous form of *K. occidentalis* is not clear, although a photograph of the Herbarium Moricand sheet strongly suggests the latter.



FIG. 1. Type sheet of *Apogon gracilis*, G-DC; lectotype plant is the tall specimen at the left.

Krigia cespitosa (Raf.) K.L. Chambers var. **cespitosa**. *Serinia cespitosa* Raf., Fl. ludov. 149. 1817. *Krigia? oppositifolia* Raf., op. cit. 57, nom. invalid. *Krigia cespitosa* (Raf.) K.L. Chambers, J. Arnold Arbor. 54:52-53. 1973. *Krigia cespitosa* (Raf.) K.L. Chambers forma *cespitosa* in K.-J. Kim, Brittonia 44:196. 1992. TYPE: LOUISIANA: Natchitoches, open ground, 15 Apr 1915. E.J. Palmer 7220 (NEOTYPE: MO! ISONETOTYPE: NY!)

As is well known, Rafinesque's *Florula Ludoviciana* (1817) was a translation of part of the French traveler C.C. Robin's publication describing his voyages to Louisiana, Florida, and the West Indies, in which Rafinesque proposed many new species and genera. Collections by Robin have never been located. The above species was described first on page 57 as *Krigia? oppositifolia*, but that name was rejected by the author on page 149 of the "Additions," and *Serinia cespitosa* was substituted (Chambers 1973). American authors have been in agreement as to what species Rafinesque was referring, but its name has not before been typified.

A HYBRID KRIGIA FROM THE MOUNTAINS OF NORTH CAROLINA

It was long ago reported that a hexaploid hybrid population of *Krigia* occurs on the Blue Ridge Parkway northeast of Asheville, North Carolina (Chambers 1965; Vuilleumier 1973), but its formal taxonomic recognition has been delayed until the present. The parental taxa are *K. montana* (Michx.) Nutt. ($n = 10$) and *K. biflora* (Walter) S.F. Blake ($n = 5$), whose area of sympatry is limited to the southern Appalachian Mountains. *Krigia montana* is endemic to this region (Shinners 1947; Wiser 1994), occurring mainly on granitic balds, cliffs, talus, and roadbanks, principally in North Carolina but extending into South Carolina, Georgia, and Tennessee in similar habitats. It is consistently tetraploid (Tomb et al. 1978). *Krigia biflora* is much more widespread, occurring in woodlands and low prairies throughout the northeastern United States and parts of southern Canada, ranging south to Georgia, Alabama, and Arkansas, with disjunct populations in Colorado, New Mexico, and Arizona (Kim & Turner 1992). In the Blue Ridge of North Carolina it is found principally in the shrub bald community (Ramseur 1960), and both diploid ($n = 5$) and tetraploid ($n = 10$) populations are known.

At Craggy Gardens on the Blue Ridge Parkway, ca. 12 air line km northeast of Asheville, Buncombe County, hexaploid plants were found that were intermediate in various respects between the two above species. Their population will be described below. Samples from this site, along with samples of *K. montana* and of diploid and tetraploid *K. biflora* were contributed to the research of K.-J. Kim, University of Texas, and are mentioned in his various publications. His biochemical studies involved the whole genus and included both chloroplast DNA, examined through restriction site analysis, and nuclear rDNA, for which restriction sites and ITS sequences were utilized. Because the chloroplast genome is inherited maternally, it was expected that the hybrid's chloro-

plants would resemble one parent more than the other. In the cladistic analysis, the maternal parent proved to be diploid *K. biflora* (Kim et al. 1992). In the ITS sequence study, the hybrid did not associate closely with either parent but instead, in the strict consensus tree, formed an unresolved branch at the node basal to the two parents (Kim & Jansen 1994). However, a relationship of the hybrid with *K. montana* was shown in the analysis based on rDNA restriction sites (Kim and Mabry 1991). The hexaploid "exhibited combined length polymorphism patterns of the diploid *K. biflora* and the tetraploid *K. montana*." These studies leave no doubt that the Craggy Gardens plants are indeed the allopolyploid hybrid of *K. biflora* \times *K. montana*.

In order to call attention to this hybrid and to provide a name for use by those interested in studying it further, the following taxon is here described:

Krigia \times shinersiana K.L. Chambers, hybrid nov. (**Fig. 2**). TYPE: U.S.A. NORTH CAROLINA. BUNCOMBE CO.: Craggy Gardens, Blue Ridge Parkway 18.6 mi N of junction with Hwy. 70 E of Asheville, at the observation hut on grassy bald above the parking lot, elev. 5340 ft, grassy turf over granite substrate, 21 Jul 1968, K.L. Chambers 2880 (HOLOTYPE: OSC; ISOTYPES: GH, MO, NY, OSC, US).

Hybrida inter *Krigiam bifloram* et *K. montanam* intermedia caule inferne et superne ramoso foliato ramis superne folia redacta ferens ab capitulis longi-pedunculatis 1-3 simul terminatis, cypselis 3.5 mm longis, floribus aurantiaco-luteis, chromosomatum numerus $2n = 60$.

Perennial herb with short rhizome, propagating by adventitious buds from the rootlets, stems decumbent or erect, to 65 cm tall, leaves of the basal rosette 8-30 cm long, oblanceolate, tapering to a narrowly winged petiole, acute, entire or dentate to pinnatifid with remote, straight or arcuate, acute lobes, lower cauline leaves similar, 14-25 cm long, upper leaves reduced, lanceolate with broad, clasping petiole, peduncles 14-28(-30) cm long, glandular-villous towards apex, involucre 7-10 mm high in flower, 8-13 mm high in fruit, phyllaries 11-13, equal, lanceolate, attenuate, green, glabrous or lightly glandular-villous, florets 20-23 mm long. The name honors Lloyd H. Shinners, whose valuable monograph (1947) forms the basis for studies of the genus.

Additional collections: U.S.A. NORTH CAROLINA. Buncombe Co.: Blue Ridge Parkway, mile 364.4 R., Craggy Flats, in bald near trail shelter on Craggy Gardens nature trail, 14 Jul 1977, T. Govus 231 and Dan Pittillo (WCUH) Buncombe Co.: Scattered in grassy bald, top of Craggie Mt., 15 Jul 1935, H.J. Oosting 35453 (DUKE).

A comparison of habit and flower color in *Krigia* \times *shinersiana* and its two parents is given in Table 1. Differences in the cypselae also were noted (Fig. 3). Fruits of the hybrid were consistently longer, at 3.5 mm, than in either *K. biflora* (3.0 mm) or *K. montana* (2.5-3.0 mm). In *K. biflora* the ribs of the cypselae are low and of equal prominence nearly to the base, whereas in *K. montana*, 3 ribs are usually more prominent than the others in adaxial view, some other ribs being suppressed. In *K. \times shinersiana* the ribs in adaxial view arise at the base in groups of 3, with the central rib being more prominent to near the cypselae



FIG. 2. Holotype of *Krigia* \times *shinnersiana*, OSC.

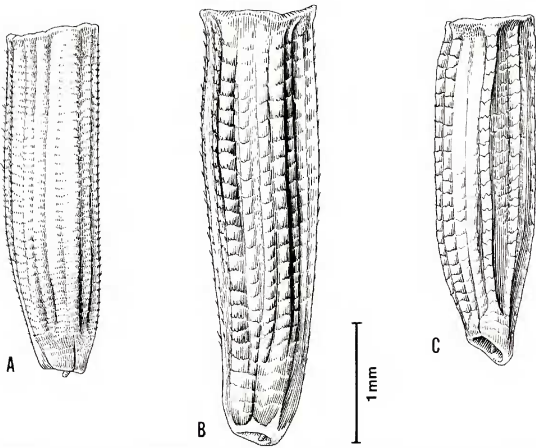


FIG. 3. Cypselae of *Krigia* \times *shinnersiana* and its parental taxa. A. *Krigia biflora* (Chambers 1404), B. *K. x shinnersiana* (Chambers 1362), C. *K. montana* (Chambers 1360). Pappi not shown.

apex. The number of bristles per cypselus was compared, using mature heads collected in glass vials to avoid shattering the delicate pappi (Table 2). Bristle numbers in *K. biflora* are distinctly greater than in *K. montana*, while the hybrid numbers vary from those of *K. montana* up to an approximately intermediate number. If bristle number is assumed to have a genetic component, the range of numbers in the hybrid, sampled at different times from the type locality, suggests that two or more different genotypes are present.

The type locality is reached by a trail heading south 0.5 km from the Visitors Center at the Craggy Gardens parking area, to a hikers' shelter constructed of weathered chestnut beams. The grass bald south of the shelter is being invaded by small shrubs of *Rhododendron catawbiense* from the surrounding heath bald community (Ramseur 1960:90). *Krigia montana* is common on Craggy Pinnacle north of the parking area but was not seen in the heath or grass bald communities along the south trail. *Krigia biflora* was never noted in this vicinity during my field studies. Observations made in 1995 found the hybrid to be abundant in two areas of the bald, forming colonies near small shrubs of *Rhododendron* and *Vaccinium*. The absence of variation in transplants from

TABLE 1. Comparison of habit and flower color of *Krigia biflora*, *K. montana*, and *K. × shinnersiana*. *Measured by means of Nickerson Color Fan (Munsell Color Co., Baltimore, MD). Floral pigments of *Krigia* spp. identified as carotenoids by Harborne (1997).

<i>Krigia biflora</i>	<i>Krigia × shinnersiana</i>	<i>Krigia montana</i>
Stems naked below or with one large leaf low-down; modified clasping leaf higher up.	Same as <i>K. montana</i>	Cauline leaves well-developed, with axillary branches above basal leaf rosette.
Main stem ending in umbellate cluster of 2–6 naked floral peduncles.	Main stem ending in cluster of 1–3 naked floral peduncles.	Main stem usually terminated by a single naked floral peduncle.
Terminal cluster of peduncles subtended by 1–3 bracts up to 3(–5) cm long.	Terminal peduncles subtended by 1–3 bract-like leaves up to 9(–11) cm long.	Terminal peduncle subtended by 1–2 leaves up to 18 cm long.
Later inflorescences may arise in axils of clasping upper leaf and lower stem leaf.	Same as <i>K. montana</i>	Later inflorescence branches arise in axils of stem leaves and leaves subtending terminal peduncle.
First floral peduncle not arising singly from basal leaf rosette.	Same as <i>K. biflora</i>	First floral peduncle may arise singly near basal leaf rosette.
Flower color Munsell Hue 10YR 8/10 moderate orange yellow.*	Flower color Munsell Hue 5Y 8/12, vivid yellow.	Flower color Munsell Hue 7.5Y 8/12, vivid greenish yellow.

TABLE 2. Mean number of pappi bristles per cypsela in plants of *Krigia biflora*, *K. montana*, and *K. × shinnersiana*. Collections of the latter taxon were made at Craggy Gardens at various times. The standard deviation, range, and number of cypselae sampled are given. See Appendix for other locality information.

Collection	Mean	S.D.	Range	Number
1207 <i>biflora</i> 2x	36.86	2.97	30–42	28
1404 <i>biflora</i> 4x	31.88	3.15	26–39	24
2894 <i>montana</i>	15.38	1.36	13–18	16
2881 <i>montana</i>	18.67	1.36	16–22	27
2887 <i>montana</i>	21.13	1.46	20–23	8
2889 <i>montana</i>	21.88	1.45	19–25	16
2888-1 <i>shinnersiana</i>	18.49	1.64	14–22	38
2880 <i>shinnersiana</i>	19.48	1.35	16–22	29
2888-2 <i>shinnersiana</i>	20.74	1.95	18–23	50
2879-2 <i>shinnersiana</i>	21.16	2.41	17–26	76
1362 <i>shinnersiana</i>	24.17	2.17	21–28	12
2879-5 <i>shinnersiana</i>	24.80	2.07	20–28	20
2879-3 <i>shinnersiana</i>	27.70	1.52	25–30	20

each colony suggests that reproduction is largely clonal. One such colony was located 31 m southeast of the shelter, just east of an incised walking trail, while another was found 28 m southwest of the shelter, west of a second trail. The two colonies differ in leaf shape (nearly entire vs. sharply pinnately lobed) and probably represent different genotypes. Fruit-set is high when hybrid plants are cross-pollinated experimentally, but seedling establishment may be infrequent in the dense stand of *Carex* and grasses of the bald.

As discussed by Wiser and White (1999), grass balds of the Southern Appalachians were used as summer grazing pastures until around 1930, but they are not maintained by current natural processes and are subject to woody plant invasion. The bald at the type locality, under the name Craggy Flats, was described by Pittillo and Govus (1978), who included a brief list of the herbaceous flora. *Krigia* \times *shinneryana* was mentioned in this list under the name *K. biflora* (voucher checked by the author). It is tempting to speculate that the hybrid originated over 70 years ago, in the period of cattle grazing, when habitat disturbance was greater than now and open ground was more available for hybrid seedling establishment. The two parental species must have been in genetic contact over a long period of time in this mountainous region, and we can expect to find the products of their hybridization at other sites as well. Evidence of this is the discovery of pentaploid plants referable to *Krigia biflora* at two sites along the trail up Mt. Pisgah from the Blue Ridge Parkway, Haywood County, NC (Chambers 2891, 2893). The habitat was trail-side in a shrub bald about 50 m below the summit communications tower, in very different conditions than the grass bald at Craggy Flat. Morphology of the plants suggests a contribution of *K. montana* to their origin. It is hoped that this report will stimulate interest and further study by persons to whom these sites on the Blue Ridge Parkway are readily accessible.

APPENDIX: COLLECTIONS CITED

***Krigia biflora*.**—NEW JERSEY. Atlantic Co.: Nesco, 21 May 1957, *Chambers* 1207. WEST VIRGINIA. Nicholas Co.: 7.7 mi N of Mt. Nebo, 30 Aug 1958, *Chambers* 1404. NORTH CAROLINA. Haywood Co.: trail up Mt. Pisgah, where vegetation changes to *Kalmia* scrub with oaks, 21 Jun 1968, *Chambers* 2891; same, 50 yards down trail from summit tower, *Chambers* 2893. ***Krigia montana*.**—NORTH CAROLINA. Rutherford Co.: Chimney Rock Park, 7 Jun 1958, *Chambers* 1360. Buncombe Co.: Blue Ridge Parkway, Craggy Pinnacle, 20 Oct 1967, *Chambers* 2881; same, nature trail by Craggy Gardens parking lot, 20 Jun 1968, *Chambers* 2887. Buncombe Co.: Blue Ridge Parkway, Balsam Gap, 6.5 mi NE of Craggy Gardens, 20 Jun 1968, *Chambers* 2889. SOUTH CAROLINA. Greenville Co.: Caesar's Head, 22 Jun 1968, *Chambers* 2894. ***Krigia* \times *shinneryana*.**—NORTH CAROLINA. Buncombe Co.: grassy bald at observation hut on trail S of Craggy Gardens parking lot, 8 Jun 1958, *Chambers* 1362; same, 20 Oct 1967, *Chambers* 2879, 2880; same, 20 Jun 1968, *Chambers* 2888.

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REFERENCES

- CHAMBERS, K.L. 1963. Amphitropical species pairs in *Microseris* and *Agoseris* (Compositae: Cichorieae). *Quart. Rev. Biol.* 38:124–140.
- CHAMBERS, K.L. 1973. *Krigia cespitosa*. In: B.S. Vuilleumier, The genera of Lactuceae (Compositae) in the Southeastern United States. *J. Arnold Arbor.* 54:52–53.
- CHAMBERS, K.L. 1965. An allopolyploid *Krigia* from the southern Appalachians. *Amer. J. Bot.* (Abstr.) 52:658.
- CORRELL, D.S. and M.C. JOHNSTON. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.
- DECANDOLLE, A.P. 1838. *Prodromus systematis naturalis regni vegetabilis*. Pars 7. Treuttel & Wurtz, Paris.
- DIGGS JR., G.M., B.L. LIPSCOMB, and R.J. O'KENNON. 1999. Shinnery & Mahler's illustrated flora of north central Texas. Botanical Research Institute of Texas, Fort Worth.
- ELLIOTT, S. 1824. A sketch of the botany of South-Carolina and Georgia. Facsimile ed. 1971, Hafner Publ. Co., New York.
- GRAY, A. 1884. Synoptical flora of North America. Vol. I, Part II. Ivison, Blakeman, Taylor & Co., New York.
- GREUTER, W. et al. 1988. International code of botanical nomenclature. *Regnum Veg.* 118. Koeltz Scientific Books, Koenigstein.
- GREUTER, W. et al. 2000. International code of botanical nomenclature. *Regnum Veg.* 138. Koeltz Scientific Books, Koenigstein.
- HARBORNE, J.B. 1977. Variations in pigment patterns in *Pyrrophappus* and related taxa of the Cichorieae. *Phytochem.* 16:927–928.
- JEPSON, W.L. 1925. A manual of the flowering plants of California. Univ. of California, Berkeley.
- KIM, K.-J. and T.J. MABRY. 1991. Phylogenetic and evolutionary implications of nuclear ribosomal DNA variation in dwarf dandelions (*Krigia*, Lactuceae, Asteraceae). *Pl. Syst. Evol.* 177:53–69.
- KIM, K.-J. and B.L. TURNER. 1992. Systematic overview of *Krigia* (Asteraceae—Lactuceae). *Brittonia* 44:173–198.
- KIM, K.-J., B.L. TURNER, and R.K. JANSEN. 1992. Phylogenetic and evolutionary implications of interspecific chloroplast DNA variation in *Krigia* (Asteraceae—Lactuceae). *Syst. Bot.* 17:449–469.
- KIM, K.-J. and R.K. JANSEN. 1994. Comparisons of phylogenetic hypotheses among different

- data sets in dwarf dandelions (*Krigia*, Asteraceae): additional information from internal transcribed spacer sequences of nuclear ribosomal DNA. *Pl. Syst. Evol.* 190:157–185.
- PITTILLO, J.D. and T.E. GOVUS. 1978. Important plant habitats of the Blue Ridge Parkway from the Great Smoky Mountain National Park to Roanoke, Virginia. Southeast Regional Office, National Park Service.
- RAFINESQUE, C.S. 1817. *Florula ludoviciana*. C. Wiley & Co., New York.
- RAMSEUR, G.S. 1960. The vascular flora of high mountain communities of the southern Appalachians. *J. Elisha Mitchell Sci. Soc.* 76:82–112.
- SHINNERS, L.H. 1958. Spring flora of the Dallas-Fort Worth area, Texas. Lloyd H. Shinnars, Dallas.
- SHINNERS, L.H. 1947. Revision of the genus *Krigia* Schreber. *Wrightia* 1:187–206.
- TOMB, A.S., K.L. CHAMBERS, D.W. KYHOS, A.M. POWELL, and P.H. RAVEN. 1978. Chromosome numbers in the Compositae. XIV. Lactuceae. *Amer. J. Bot.* 65:717–721.
- VUILLEUMIER, B.S. 1973. The genera of Lactuceae (Compositae) in the southeastern United States. *J. Arnold Arbor.* 54:42–93.
- WISER, S.K. 1994. High-elevation cliffs and outcrops of the southern Appalachians: vascular plants and biogeography. *Castanea* 59:85–116.
- WISER, S.K. and P.S. WHITE. 1999. High-elevation outcrops and barrens of the southern Appalachian Mountains. Pp. 119–132. In: R.C. Anderson, J.S. Fralish, and J.M. Baskin, eds. *Savannas, barrens, and rock outcrop plant communities of North America*. Cambridge Univ. Press.